Preliminary Engineering Report

For

2 MG Water Storage Facility

Low System Zone

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I

INTRODUCTION

A.   General Information

The Town of Blacksburg water system consists of three primary pressure zones: 1) the Low system zone; 2) the High system zone; and 3) the Laurel Ridge zone. The Low system zone encompasses the majority of the water system, and is served by four water storage tanks (as summarized in Table III-1).   The total storage capacity in the Low system is 4.5 million gallons (MG). During the winter of 1994, a majority of the Town lost water due to a power loss at the water treatment plant during a winter storm event. The existing water storage facilities did not provide enough storage to maintain water service while the power was restored to the plant. Most of the Town was without water for an extended period of time. The Town would like additional storage for emergency conditions. The Town has identified the site of the existing Highland Park storage tanks (and pump station) as the most feasible site for the additional water storage facility

In addition, the existing Highland Park Tanks are in poor condition and need restoration or replacement. The water tanks are critical for normal operations, and temporary removal from service is impractical.   Construction of additional storage facilities would allow temporary removal of the existing storage facilities for either refurbishment or replacement.

B.   Purpose and Scope

The purpose of this report is to address the need for additional water storage in the Low System zone. In evaluating the system, the original computer model developed by Draper Aden Associates for the Town water system was utilized. The report considers various alternatives to provide the necessary storage and includes cost estimates for implementing those alternatives.

II
WATER SYSTEM DEMAND

A.   Existing Water Demand

The Town of Blacksburg purchases its water from the Blacksburg Christiansburg VPI Water Authority (BCVPIWA). In 2001, the Town purchased an average of 3.85 millions gallons per day (MGD) from the BCVPIWA, while Virginia Tech (formerly VPI) purchased an average of 0.81 MGD. Thus the combined water demand in the Blacksburg and Virginia Tech systems is approximately 4.66 MGD based on 2001 data.

The Town's total metered consumption in 2001 was 3.03 MGD. Residential consumption was approximately 1.28 MGD, and commercial/industrial consumption was approximately 1.75 MGD. The difference in total water purchased and total metered consumption in 2001 was approximately 0.82 MGD. This is called unaccounted-for water, and includes lost water (leakage and unauthorized use), under-registration of meters, and water use for things such as fire fighting, flushing of mains and sewers, and street cleaning. Based on the above data, unaccounted-for water in 2001 was approximately 21% of the total water delivered to the Town of Blacksburg.

The Low system zone encompasses a majority of the Town of Blacksburg water system, and serves both Town and County customers. Based on year 2001 data, the average water demand in the Low system zone is approximately 3.22 MGD (assuming consistent distribution of unaccounted-for water). Since Virginia Tech is supplied through the Town's Low system zone, and Virginia Tech relies on the Town for water storage, combined water demand will be used as the basis for evaluating water storage in the Low system zone. Based on 2001 records, the combined average water demand in the Low system zone and Virginia Tech systems is 4.03 MGD.

B.   Future Water Demand

Various methods can be utilized to estimate future water demand. For the purpose of this report, estimates of future water demands are based on historical trends in total water demand. Since 1977, the combined water demand in the Town and Virginia Tech systems has increased at an average rate of approximately 54,200 gallons per day (GPD) per year. According to meter records during this period, the Virginia Tech proportion has decreased while the Town proportion has increased at an average rate of approximately 66,140 GPD per year. In any case, combined water demand is the important criterion for evaluation of water storage capacity. Based on historical trends in combined water demand, total average day water demand is projected to increase as shown in Table II-1.

Table II-1
Projected Water Demand
Town of Blacksburg and Virginia Tech

Year	Water Demand (MGD)
2001	4.66
2010	5.15
2020	5.69
2030	6.23
2040	6.77

These projections represent a 22% increase in demand by year 2020. However, It should be noted that unforeseen events and developments (like the addition of one or more large industrial users) could greatly impact future water demands, and the above figures could change significantly. Based on these projections, the combined future water demand in the Low system zone and Virginia Tech is projected to be 4.92 MGD by year 2020.

III

EVALUATION OF EXISTING SYSTEM

A.   General System Information

The Town of Blacksburg purchases water from the Blacksburg-Christiansburg-VPI Water Authority. The Authority withdraws water from the New River (adjacent to the Route 114 bridge). The water is treated at the Authority's water treatment plant, located off Route 114 between Fairlawn and Christiansburg. The water treatment plant is rated at 12.4 million gallons per day (MGD). The Authority delivers finished water to the Towns of Christiansburg and Blacksburg, and Virginia Tech.

The Authority supplies the Blacksburg system through the Blacksburg Booster pump station (Triangle Pump Station). Water is delivered from the Blacksburg Booster pump station to the Highland Park tanks through approximately 16,500 feet of 16-inch waterline. The Blacksburg Booster pump station delivers water at a rate of approximately 2,500 gallons per minute (GPM) at 120 feet of head. The Blacksburg water distribution network consists of pipes varying from 2-inch to 20-inch in diameter.

As previously stated, the Blacksburg water system consists of three primary pressure zones: 1) the Low system zone; 2) the High system zone; and 3) the Laurel Ridge zone. The Low system zone encompasses the majority of the water system, and is served by four water storage tanks (as summarized in Table III-1). The High System zone is supplied from the Low system through the Highland Park pump station. The High system zone is served by the North Main water tank, which is an elevated tank with a capacity of 500,000 gallons and an overflow elevation of 2413.5 feet. The Laurel Ridge zone is supplied from the Low system through the Laurel Ridge pump station. The Laurel Ridge zone is served by the Laurel Ridge tank, which is a welded steel tank with a capacity of 30,000 gallons.

The Low system includes the two Highland Park water storage tanks, the Neil Street water storage tank, and the Allegheny Street water storage tank. The Allegheny Street water

storage tank (which has a higher overflow elevation) is fed from the High system zone, and then serves the Low system zone.

Table III-1
Water System Storage

Water Storage Tank	Capacity (Gallons)	Overflow Elevation (Feet)
Highland Park 1	1,000,000	2,284
Highland Park 2	500,000	2,284
Neil Street	2,000,000	2,284
Allegheny Street	1,000,000	2,372
Low System Zone Total	*4,500,000*	
North Main	500,000	2,413
Laurel Ridge	30,000	2,583
Entire System Total	*5,030,000*	

The average water demand in the Low system zone is approximately 3.22 MGD (assuming a 21% unaccounted-for water rate throughout the system), with approximately 150,000 GPD of that amount returning to the Low system through the Allegheny Street water tank. Since the Virginia Tech water system does not have its own storage, the demand in the Virginia Tech system should be taken into account in evaluating storage capacity. The average water demand in the Virginia Tech system is approximately 0.81 MGD. Thus the combined average demand is approximately 4.03 MGD.

B.   Problem Definition

Assuming existing, normal conditions, water storage is adequate for the Low system. A detailed analysis of the water storage capacity is provided below. However, the Town would like additional storage for emergency conditions. As previously mentioned, a majority of the Town lost water due to a power loss at the water treatment plant during the winter of 1994. The existing water storage facilities did not provide enough storage to maintain water service while the power was restored to the plant. Most of the Town was without water for an extended period of time. The Town would like to increase its storage capacity to provide 48 hours of storage.

In addition, the Highland Park Tanks are in poor condition and need restoration or replacement. The water tanks are critical for normal operations, and temporary removal from service is impractical. Construction of additional storage facilities would allow temporary removal of the existing storage facilities for either refurbishment or replacement.

C.   Water Storage Capacity

Water storage is a crucial and necessary component of any water distribution system. In general, needed storage capacity is based on maximum day and fire flow demands and is necessary for the following reasons:

- To equalize demands on sources of supply, pumps, transmission and distribution mains by meeting hourly variations in demand,
- To help maintain uniform pressures, and
- To provide emergency storage for fires, power outages, equipment failures and waterline breaks.

These primary functions of storage can be separated into three distinct areas of need: equalization or operating storage, fire flow storage and emergency reserve storage.

Equalization storage can be determined by using 20% of the maximum day demand. Maximum day demand is approximately 1.4 times average day demand. Based on an average Low system/Virginia Tech demand of approximately 4.03 MGD, maximum day demand would be 5.64 MGD. Thus an estimated volume of 1.13 million gallons (MG) would be needed for equalization storage. Needed fire flow is generally based on guidelines contained in the Fire Suppression Rating Schedule published by Insurance Services Office (ISO). Needed fire flow applies to particular structures and is based on a number of factors including floor area, type of construction, occupancy and exposure to other structures. Since the Low system service area includes a great variety of structures, use of ISO criterion is impractical, thus needed fire flows will be assumed. In particular, a fire flow of 1,500 GPM will be assumed based on the possible fire flow needs of the downtown area. If it is determined that higher fire flows are required,

additional storage volume would be needed. Based on a fire flow of 1,500 GPM for a two-hour duration, 180,000 gallons would be needed for fire flow reserve storage. Emergency reserve storage is frequently estimated using 50% of the maximum day demand. Based on this criterion, 2.82 MG of storage would be needed for emergency reserve storage. Thus the total needed storage volume for the Low system would be at least 4.13 MG under existing demand conditions.

As previously stated, the combined future average water demand in the Low system zone and Virginia Tech is projected to be 4.92 MGD in year 2020. Thus, using the above criteria, the total needed storage should be at least 5 MG in year 2020. Therefore, with an existing storage capacity of 4.5 million gallons in the Low system zone, additional storage capacity is needed within the next 20 years to meet projected water demands.

Based on average water demand in the Low system zone and Virginia Tech, a storage capacity of 5 MG would provide 30 hours of storage immediately, and 24 hours of storage in year 2020. However, the Town would like to have 48 hours of storage. To obtain this level of storage, at least 8 MG of storage would be needed under existing demand conditions, and nearly 10 MG of storage would be needed in year 2020.

The Town has been considering adding a 2 MG water tank to the Low system zone, thus providing a total storage capacity of 6.5 MG for the Low system and Virginia Tech. A storage capacity of 6.5 MG would provide 39 hours of storage immediately, and 32 hours of storage in year 2020. Though adding a 2 MG water tank would not totally achieve the Town's goal of 48 hours of storage, it would provide a 45% increase in storage capacity in the Low system, which is a significant improvement to the system. Constructing larger storage facilities is a possibility, but conditions at the proposed site limit the size of the storage tank presently under consideration (as discussed below).

The Town has already identified the site of the existing Highland Park storage tanks (and pump station) as the most feasible site for the additional water storage facility. The space on this site is limited. The site (roughly 150 feet wide by 540 feet deep) already contains two large water

tanks and two pump station buildings. In addition, its proximity to adjacent residential properties is a limiting factor. The site can accommodate a 2.0 MG water tank, but construction of a significantly larger tank is not feasible. Thus, a 2.0 MG water tank is recommended.

Since the Town of Blacksburg provides needed storage for both the Town and Virginia Tech, the specific portion needed for Virginia Tech may be of interest. Assuming an existing average water demand of 0.81 MGD along with the tank sizing criteria presented above, Virginia Tech needs approximately 974,000 gallons of storage under existing conditions. In order to determine future needs for Virginia Tech, water demand projections are needed for the Town and Virginia Tech, individually (the water demand projections discussed earlier in this report were based on past trends of *combined* water demand). However, according to meter records, the Virginia Tech water demand has decreased in recent years, and has remained relatively steady since 1977. Thus if future water demand projections are based on past trends, needed future storage capacity for Virginia Tech would not significantly increase. On the other hand, assuming Virginia Tech's proportion remains constant (i.e. 20% of the combined average water demand in the Low system and Virginia Tech), their needed future storage capacity would be 1.14 MG (based on the tank sizing criteria presented above). Thus, based on the above assumptions, the Virginia Tech future proportion of storage may be between 0.97 and 1.14 MG.

D.   Water Storage Elevation

The primary criteria used in evaluating water storage elevation are "hydraulic grade" and "effective storage." For a water system involving pumped storage, the hydraulic grades are established by the water tank overflow elevations. As previously noted, the existing overflow elevation of the Highland Park and Neil Street Tanks is 2,284 feet, thus establishing the base hydraulic grade elevation for the Low system zone. This elevation has supplied adequate pressures to the Low system zone and does not need modification. Therefore, any provisions for additional storage capacity should be designed to match this hydraulic grade.

"Effective storage" is defined as the volume of water contained above the elevation required to maintain minimum pressures of 20 pounds per square inch (PSI) throughout the zone

the tank serves. For example, if a water tank is almost empty, but all areas within its zone maintain pressures at or above 20 PSI, the tank is considered 100% effective. If the tank must be half-full to maintain minimum pressures at or above 20 psi throughout the zone, the effective storage of the water tank is only 50% of its total capacity.

As previously stated, the Neil Street and Highland Park tanks serve the Low system. According to the hydraulic modeling performed on the Town's water system, both the Neil Street tank and the existing Highland Park tanks are 100% effective. Hydraulic modeling was performed to determine the effective storage conditions for the proposed tank. The modeling results are contained in Appendix A of this report. In general, as long as the water level in the storage tank is at or above elevation 2251 feet, the storage will be 100% effective.

Since the minimum water level for effective storage is 2251 feet, only 33 vertical feet is available for effective storage (assuming an overflow elevation of 2284 feet). The site is 148.5 feet wide. The Town zoning ordinance requires a 30-foot buffer zone between adjacent properties and the tank. Thus the maximum outside horizontal dimension of the tank (diameter or width) is 88.5 feet. To provide margin, a maximum inside dimension of 85 feet will be assumed. For a circular tank with an inside diameter of 85 feet, the volume of effective storage is limited to 1.4 MG. To achieve a storage capacity of 2 MG, an 85-foot diameter tank would need a bottom elevation of 2237 feet. Thus the bottom 14 vertical feet of a 2 MG tank would not be considered "effective." In other words, a 2 MG tank would be considered 70% effective based on Virginia Department of Health criteria.

Hydraulic modeling was performed to predict system conditions at a water level of 2238 feet (i.e., 1 foot above the floor of a 2 MG tank). While minimum pressures dropped below 20 PSI at particular points within the system, minimum pressures stayed above 15 PSI. Thus while the bottom 14 vertical feet would not be considered "effective," it could be considered "useful" under extreme emergency conditions. In any case, since available ground elevations range from 2235 to 2240 feet, founding the tank at an elevation of 2251 feet would not suit the site conditions. A floor elevation of approximately 2237 feet would suit the site conditions well.

IV

ALTERNATIVES FOR ADDITIONAL WATER STORAGE

A.   Requirements

1.   General

As previously indicated, a 2.0 million gallon storage tank is recommended at the existing Highland Park Tank site. To maintain the existing hydraulic grade of the Low system, the overflow elevation of the new tank should be equivalent to the overflow elevation of the existing Highland Park tanks, which is 2284 feet. Since the minimum water level for effective storage is 2251 feet, the diameter of the tank should be maximized. On the other hand, because of space limitations and buffer zone requirements, the maximum inside diameter of the tank should be 85 feet. Thus the tank dimensions for a 2 MG tank must be approximately 85 feet in diameter by 47 feet high (side water depth).

Another option involves underground storage (thus meaning a lower overflow elevation), and using pumps to provide the appropriate hydraulic grade. This option is discussed later in this section.

2.   Foundation Requirements

A subsurface exploration and geotechnical evaluation was performed for the proposed site. The exploration revealed soft soils of varying thickness under the proposed tank, which would likely result in an undesirable amount of settlement and differential settlement for a shallow foundation. Thus, it was recommended that the tank foundation be designed utilizing end bearing piles, designed to bear on the rock encountered. The additional construction cost associated with this type of foundation is estimated to range from $175,000 to $200,000. This additional cost is included in the tank costs given below.

B.   Above-Ground Alternatives

1.   General

A ground level tank is generally the most cost effective type of tank (relative to below-ground and elevated tanks), assuming the suitability of available ground elevations and horizontal space. Various alternatives are presented below. All estimated costs are in year 2002 dollars.

2.   Welded or Bolted Steel Tank

Historically in this region, welded steel tanks have been the most common type of tank used for public water storage. In recent years, more water suppliers have begun using other types of tanks due to the increasing maintenance costs associated with the repair and recoating of welded steel tanks. At the same time, coating systems have improved and corrosion protection systems have been developed to increase durability. Still, the need for periodic repair and recoating is a concern for many water suppliers. In general, regular maintenance will probably include the following:

- Professional tank inspection every five years
- Interior spot repair and exterior wash and recoating at 10 years
- Full-field blast and recoating of interior and exterior at 20 years
- Repetition of the previous three steps[1]

The process of recoating involves complete dewatering, repair (if needed), cleaning, surface preparation, coating, curing, disinfection and filling, resulting in significant downtime for the facility (probably more than 30 days).

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[1] Information is from Steel Plate Fabricators Association, Des Plaines, IL. A more frequent need for recoating is reported from other sources.

Welded steel tanks can be constructed to various dimensions, including the range noted above. The tanks can be designed using various roof styles, and architectural treatments (such as ornamental pilasters) can be added for aesthetic enhancement. A 2.0 MG welded steel tank would take approximately 7 months to construct. The estimated construction cost for a 2.0 MG welded steel tank is $720,000 to $750,000 and the cost of recoating is estimated at $95,000 every 20 to 25 years. Bolted steel tanks have similar characteristics and costs.

3.   Factory-Coated Bolted Steel Tank

Factory-coated bolted steel tanks (such as Aquastore tanks) provide much more durable coating systems, thus reducing the maintenance concerns associated with other steel tanks. However, a factory-coated tank is not a feasible option for this site because the manufacturers do not make standard tanks that will meet the particular site conditions. Factory-coated tanks with the required capacity (2.0 MG) are constructed with too large a diameter (95 feet minimum) and too short a height (42 feet maximum) to fit the space and elevations available at the site.

4.   Prestressed Composite Tank

Prestressed composite tanks (such as Crom tanks) are constructed using a steel shell diaphragm encased in a shotcrete core wall. Prestressing wires apply compression forces to the core wall, and an exterior shotcrete cover coat fully encases the prestressing wires. Prestressed composite tanks are constructed in accordance with AWWA and ACI standards and have a proven history of relatively low maintenance service in various environments. A prestressed composite tank is not maintenance free, but typically, the interior does not need recoating, and the exterior can be repaired or refurbished without taking the tank out of service.

Prestressed composite tanks manufacturers offer attractive architectural treatments to enhance aesthetics, and unlike steel tanks, the tank can be partially buried to

maintain existing ground contours. The tanks are constructed in standard sizes suitable for the site, including 85 feet diameter by 47 feet high. A 2.0 MG prestressed composite tank would take approximately 3 months to construct. The estimated construction cost is $713,000. Architectural treatments could add between $25,000 to $100,000 to the cost.

5. Precast Post-Tensioned Concrete Tank

Post-tensioned concrete tanks (such as Dutchland, Inc. tanks) are constructed of precast, post-tensioned, concrete panels, and typically utilize precast concrete columns and a concrete roof or an aluminum dome. Like prestressed composite tanks, long-term maintenance costs are relatively low, especially when equipped with stainless steel or aluminum accessories. Also, the tank can be partially buried to maintain existing ground contours, or completely buried for underground installation. Because of the construction methods used, the precast post-tensioned tank can be constructed in colder weather conditions than the prestressed composite tank.

Precast post-tensioned concrete tanks can be constructed in standard sizes suitable for the site, including 85 feet diameter by 48 feet high. A 2.0 MG post-tensioned concrete tank would take approximately 3 months to construct. The estimated construction cost is $835,000. Architectural treatments could add between $20,000 to $60,000 to the cost.

C. Underground Alternatives

An underground storage tank would better hide the storage structure from view, though the top of the tank would still need to be above grade as discussed below. However, there are numerous disadvantages with underground storage relating to constructiblility, additional facilities, capital expense, hydraulic function, operational complexity, and operating and maintenance expenses. Assuming construction of the new tank on the available land (that is, not replacing one of the existing tanks), construction of an underground storage tank would require deep and difficult excavation, especially considering the narrow area available for the tank. The required exterior dimensions for a rectangular, cast-in-place, "flat" roof structure would be

roughly 88 feet by 116 feet, with a depth of 33 feet overall. Due to the horizontal space limitations, vertical wall excavation and sheeting would be required around the entire perimeter of the excavation. Excavated material would need to be transported offsite, whether for disposal or return to the site for backfilling and finish grading.

The depth of the excavation would be determined by the allowable height of the structure above the finished grade. According to VDH regulations, underground water storage reservoirs must meet the following requirements: (1) The bottom of the reservoir must be above the groundwater table; (2) The top of the reservoir must be at least two feet above the normal ground surface. Considering these requirements and the equally significant difficulties related to deep excavation at this site, it should be assumed that the top of an "underground" structure would still be well above the finished grade. For the purposes of cost estimating, it is assumed that the structure would be 15 feet above finished grade on the Palmer Drive end of the structure. A facade and landscaping could be used to enhance aesthetics. Construction at a lower elevation may be possible, but associated capital costs would increase significantly above the opinion of construction cost provided below.

None of the underground storage would be considered "effective" based on the criteria presented earlier in this report. Underground storage would require a significantly lower hydraulic grade and pumping would be required to make it effective. Since utilization of the storage would be dependent upon pumping, an underground tank would not achieve the intended result – provision of additional effective water storage in the event of emergencies, including power outages. While construction of a pumping station equipped with an emergency generator could provide the emergency reserve capacity the Town desires, this would add significant expense and operational complexity.

Construction of a new underground storage tank would result in having adjacent storage tanks at different levels. This would require complex operations in order to maintain acceptable water quality and effectively utilize the storage. To be truly effective, the pumping system would need to supply average day demands in the system. Thus a pumping station with a capacity between 3,500 and 4,000 gallons per minute (GPM) would be needed. In addition, regular

pumping would be needed to prevent stagnation of water in the lower tank. Circulation pumps (having a lower capacity and energy requirement than the main pumps) could be used for this purpose. A better option may involve using variable frequency drives and controls on the main pumps to provide lower flow rates for the circulation function. This arrangement is assumed in the opinion of construction cost. In addition to regular pumping, the storage structure would need to be partitioned to prevent short-circuiting and assure effective circulation. Concrete wall partitions would not only provide this function, but also could be used to support the roof structure.

The opinion of construction cost for the underground option is between $1,500,000 and $1,900,000, depending upon the actual design and architectural enhancements desired for aesthetics. This includes the estimated construction cost for the 2 MG reservoir, 4,000 GPM pumping station (located at the north end of the reservoir), and an emergency generator. Based on the construction cost estimates, it is apparent that the construction cost of underground storage is at least twice the cost of the above-ground options.

Besides the significantly higher capital cost, the underground option would introduce additional operating and maintenance expenses and operational complexity not needed for the above-ground alternatives. This includes the energy and maintenance costs associated with the regular and emergency pumping operations. In addition, controls would be required to signal the pumps to operate relative to system demands and adjacent tank levels. Relative to the above-ground alternatives, such operations would be significantly more complex and inefficient (with regard to otherwise unnecessary pumping). Long term operating and maintenance concerns also include accessibility to the structure for maintenance and repair.

Considering the various disadvantages of underground storage at this particular site, underground storage is not considered a viable alternative.

D.   Site Work, Piping & Controls

The site work required depends upon the type and size of storage tank chosen for the site. In any case, the tank will use most of the width of the property, and the existing access road will need to be rerouted to go around the new tank. The width of the site is 148 feet. A buffer zone of 30 feet is required on both sides of the tank, which means the tank must be centered between the side property lines. The tank must be located between Palmer Drive and the existing pump station. A setback between 60 and 70 feet would situate the tank nicely relative to existing ground contours and proposed foundation elevations.

The finish grading will vary depending upon whether or not the tank is partially buried. The prestressed composite and precast post-tensioned concrete tanks can be partially buried to maintain existing ground contours. Considering the limited space on the site, proximity to adjacent residential properties, and buffer zone requirements, this is probably necessary.

Existing waterlines will need to be relocated to avoid conflict with the construction. Modifications to existing piping and controls need to be considered to maximize turnover in the new and existing tanks. The additional storage could contribute to concerns regarding detention times within individual tanks, which can result in water quality deterioration. However, such concerns can be minimized with appropriate piping, valves, and controls. Each of the existing tanks is equipped with a two-way altitude valve. According to Town mapping, the pipe between the two altitude valves and tanks is interconnected. Thus the altitude valves can operate in parallel, or else, either altitude valve can control both tanks.

The existing 500,000-gallon tank has a single inlet/outlet line, and the existing 1 MG tank appears to have two inlet/outlet lines. After the new tank is placed into service, turnover in the existing tanks will probably decrease. Modification to the inlet/outlet piping should be considered to encourage turnover. In particular, separate inlet and outlet lines, equipped with control or check valves, can encourage turnover. Such modifications could be implemented when the existing tanks are removed from service for maintenance, after the new tank is in operation.

The existing tanks are connected to the Low system via an existing 12-inch waterline that extends from the center of the site to the existing 16-inch waterline along Country Club Drive. Where the 12-inch waterline enters the site, it is approximately 10 feet higher in elevation than the proposed floor elevation of the new tank. Thus, in order to maintain 100% usable storage, a new inlet/outlet line is needed to connect to the existing 16-inch waterline along Country Club Drive. If a new inlet/outlet line is installed from the new tank to Palmer Drive, and then along Palmer Drive to the existing 16-inch waterline on County Club Drive, the inlet/outlet line can be laid at an elevation lower than the new tank floor. This would require approximately 300 feet of waterline between the tank and the connection on Country Club Drive.

A new 16-inch inlet/outlet line is recommended between the point of connection on Country Club Drive and the new tank, separating into a 12-inch inlet line and a 12-inch outlet line prior to entering the tank. The inlet line should be equipped with a one-way altitude valve, and the outlet line should be equipped with a check valve. To encourage turnover, the inlet and outlet lines should enter the tank on separate sides of the tank, and the inlet line should discharge at a higher elevation.

V

RECOMMENDATIONS AND CONCLUSIONS

A.   Recommendations

The Town of Blacksburg would like to increase its system storage capacity in the Low system to provide for emergency conditions and future water demands. In addition, construction of additional water storage facilities would allow temporary removal of the existing storage facilities for either refurbishment or replacement. The Town has identified the site of the existing Highland Park storage tanks as the most feasible site for the additional water storage. An additional 2 MG of storage is recommended.

Alternatives for providing a 2 MG water storage facility include above-ground and underground structures. However, underground storage is not considered a viable alternative for the reasons stated earlier in this report. Above-ground alternatives include structures made of 1) welded or bolted steel, 2) factory-coated bolted steel, 3) prestressed composite, and 4) precast post-tensioned concrete. However, a factory-coated bolted steel tank is not a viable alternative because the manufacturers do not make standard tanks that meet the particular site conditions.

Welded or bolted steel tanks are competitive on the basis of initial construction costs, but the long-term maintenance costs, relative to other alternatives, result in a significantly lower cost-effectiveness over the life of the tank. In addition, considering the buffer zone requirements and the importance of aesthetics at this site, the prestressed composite and precast post-tensioned tanks are advantageous. The prestressed composite and precast post-tensioned concrete alternatives offer lower long-term maintenance costs, shorter duration of construction, ability to be partially buried (thus allowing maintenance of existing ground contours), and better aesthetics (especially with architectural treatments). Based on preliminary budget estimates, the construction cost of the prestressed composite tank is significantly lower (though the precast post-tensioned tank has been competitive in other parts of the country).

Thus it is recommended that the design be based on utilization of a prestressed composite tank. Competing alternatives can be reconsidered as the project approaches the bidding phase. The recommended dimensions of the tank are 85 feet in diameter by 47 feet high. The tank, piping, and access road should be situated as shown on Figure V-1.
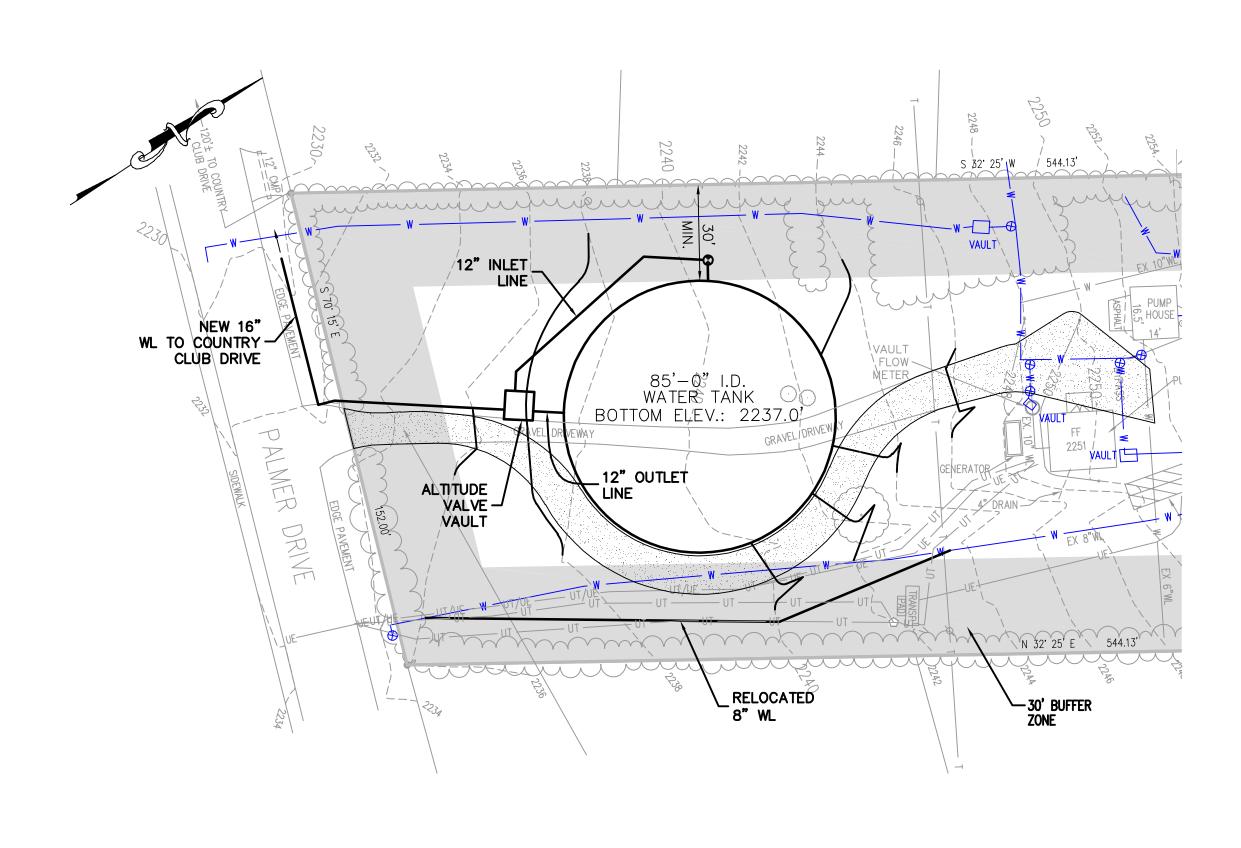
B.   Opinion of Probable Construction Cost

The estimated construction cost is shown below.

Table V-1
Opinion of Probable Construction Cost

Item	Estimated Cost
2.0 MG Prestressed Composite Water Tank (85' x 47')	$713,000
Site Piping (pipe relocation, new piping)	20,000
Off-site 16-inch Waterline	17,000
Altitude Valve Vault	35,000
Miscellaneous Site Work (earthwork, access road)	30,000
Contingency (5%)	41,000
	$856,000

Note: Above construction costs do not include architectural treatments (which could add between $25,000 and $100,000 to the cost of the tank) or special landscaping.

12" INLET LINE

30' MIN.

NEW 16" WL TO COUNTRY CLUB DRIVE

85'-0" I.D. WATER TANK
BOTTOM ELEV.: 2237.0'

ALTITUDE VALVE VAULT

12" OUTLET LINE

PALMER DRIVE

RELOCATED 8" WL

30' BUFFER ZONE

VAULT FLOW METER

PUMP HOUSE

GENERATOR

VAULT

FF 2251

GRAVEL DRIVEWAY

GRAVEL/DRIVEWAY

EX 10" WL

EX 8" WL

EX 6" WL

4" DRAIN

TRANSFER

120'± TO COUNTRY CLUB DRIVE

12" CMP

S 70° 15' E

152.00'

S 32° 25' W   544.13'

N 32° 25' E   544.13'

DESIGNED   JSL
DRAWN   JDB
CHECKED   LMR
DATE   2/14/03

PROPOSED TANK LAYOUT
HIGHLAND PARK 2.0 MG WATER STORAGE TANK
TOWN OF BLACKSBURG, MONTGOMERY CO., VA.

SCALE: 1" = 30'

FIGURE
V-1

PLAN NO.   B01277-01